# SPECIFIED GAS EMITTERS REGULATION

# QUANTIFICATION PROTOCOL FOR INNOVATIVE FEEDING OF SWINE AND STORING AND SPREADING OF SWINE MANURE

**SEPTEMBER 2007**

Version 1

Alberta
ENVIRONMENT

ALBERTANS & CLIMATE CHANGE

**Disclaimer:**

The information provided in this document is intended as guidance only and is subject to revisions as learnings and new information comes forward as part of a commitment to continuous improvement. This document is not a substitute for the law. Please consult the *Specified Gas Emitters Regulation* and the legislation for all purposes of interpreting and applying the law. In the event that there is a difference between this document and the *Specified Gas Emitters Regulation* or legislation, the *Specified Gas Emitters Regulation* or the legislation prevail.

**Acknowledgements:**

This protocol is largely based on the *Greenhouse Gas System Pork Protocol: The Innovative Feeding of Swine and Storing and Spreading of Swine Manure (Draft)* dated July 31, 2006. This work was completed under the Pork Technical Working Group (PTWG), a sub-committee of the National Offsets Quantification Team (NOQT). This work represents the culmination of a multi-stakeholder consultation project and reliance on a number of guidance documents. This document represents an abridged and re-formatted version of this work. Therefore, the seed document remains the source of additional detail on any of the technical elements of the protocol.

Any comments, questions, or suggestions regarding the content of this document may be directed to:

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ISBN: 978-0-7785-7236-7 (Printed)
ISBN: 978-0-7785-7237-4 (On-line)

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# 1.0 PROJECT AND METHODOLOGY SCOPE AND DESCRIPTION

## 1.1 Protocol Scope and Description

This quantification protocol is applicable to the quantification of direct and indirect reductions of greenhouse gas (GHG) emissions resulting from the implementation of two kinds of innovative practices on swine farms. First, the protocol quantifies GHG reductions achieved by feed substituting practices that decrease emissions. In the feeding component of the Pork Protocol, these practices substitute ingredients in the feed to reduce excretion of volatile solids (VS) by increasing energy digestibility and to reduce excretion of nitrogen (N) by optimizing amino acid balance. In the storing and spreading component, these practices substitute the season and frequency of manure spreading to decrease the conversion of VS to $CH_4$ in storage and to decrease emission of $N_2O$ after spreading. Second, the protocol quantifies reductions associated with pig husbandry practices that increase efficiency by generating less manure per unit of pigs raised. These practices reduce manure excretion by decreasing the feed and/or by decreasing the time needed to raise the pigs under project conditions. **FIGURE 1.1** offers a process flow diagram for a typical project.

The Pork Protocol does not prescribe the efficiency-type practices. Rather, this protocol serves as a generic 'recipe' for project proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements. As long as the proponent provides the evidence that less VS and/or N is excreted per unit pig raised, the practice fits within the scope of the Pork Protocol. From both kinds of innovative practices (substitution- and efficiency-type innovations), the total amount of VS and N excreted is decreased, resulting in reduction of $CH_4$ emission from stored manure and in reduction of $N_2O$ emission from land receiving manure.

The Pork Protocol quantifies emissions reductions on the basis of the pigs raised in the project. Thus, the starting point for all quantification is the number and weight of pigs produced in the project. To calculate the VS and N excretions, the Pork Protocol uses baseline pig performance (supplied by the project proponent or taken from sector-level standards) and baseline manure storage and spreading practices (set baseline of fall-emptying) to estimate the excretions that would have occurred if the pigs in the project had been raised under baseline conditions. Then, the recorded feed and sales information and the documented manure management strategy are used to calculate the project condition excretions and emissions. This approach (1) ensures the functional equivalence of the project with the baseline scenario, (2) eliminates the potential for attributing offsets for decreased numbers of pigs raised, and (3) emphasizes the efficiency objective of the Pork Protocol; namely, to encourage practices that decrease GHG emissions per unit weight of pigs raised. **FIGURE 1.2** offers a process flow diagram for a typical baseline configuration.

**FIGURE 1.1: Process Flow Diagram for Project Condition**

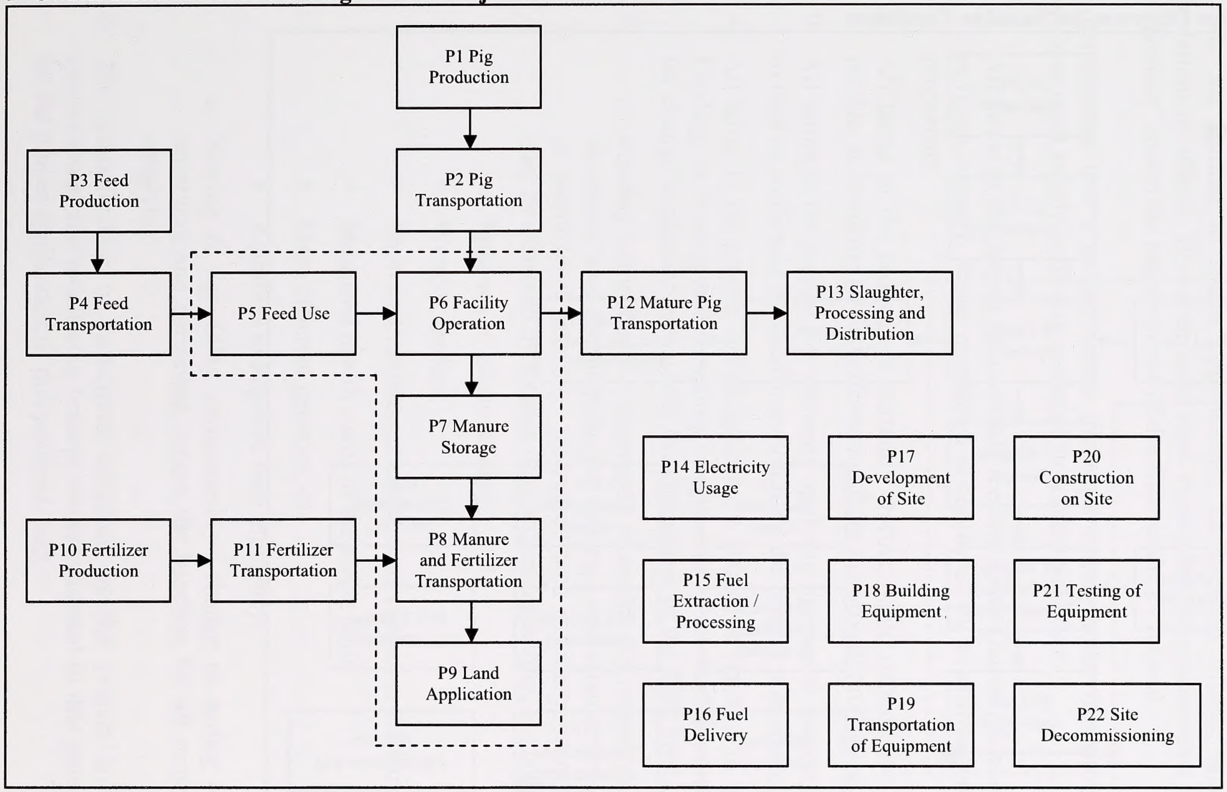
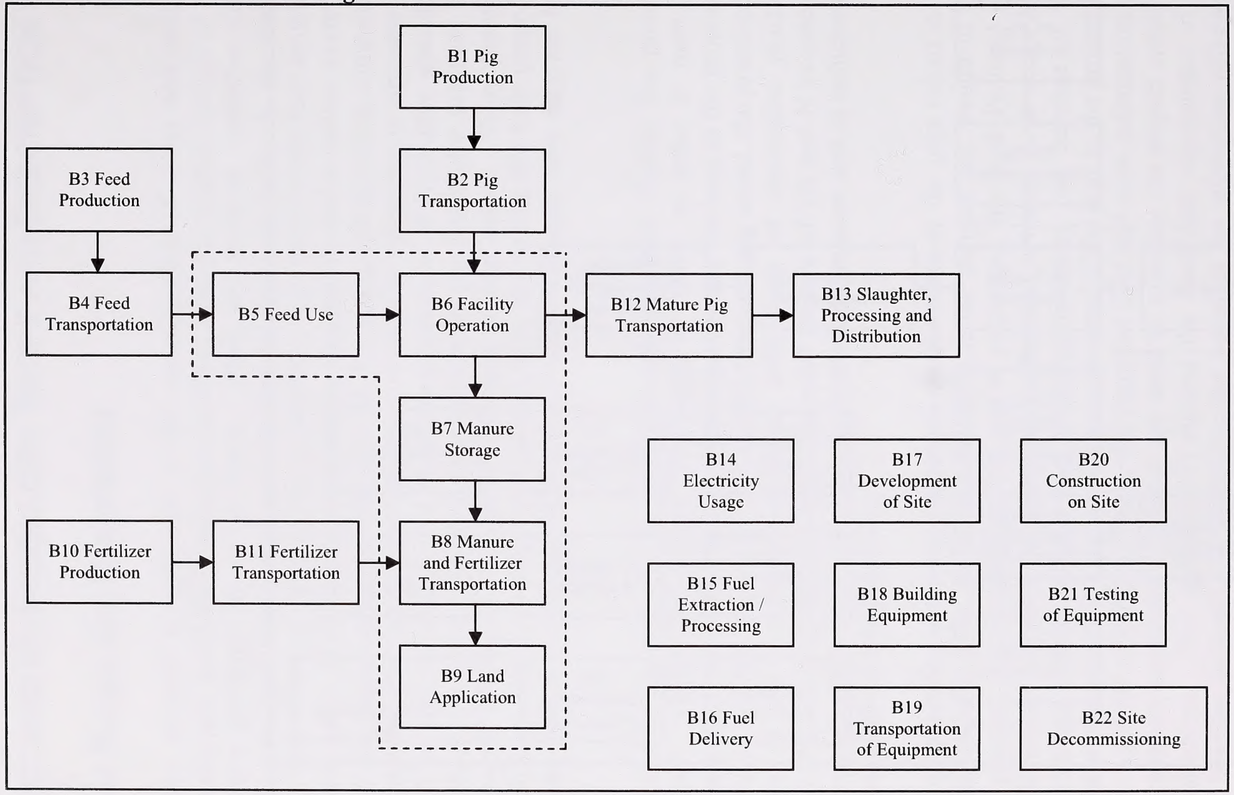


**FIGURE 1.2: Process Flow Diagram for Baseline Condition**



The boundary of the Pork Protocol encompasses the barn where the pigs are raised, the facility where liquid manure is stored, and the land where the liquid manure is spread. The project may include a number of sites, and a variety of enterprises, but all project farms will address the activities within the boundary of the Pork Protocol.

The Pork Protocol implements science- and policy-based principles and decisions that are similar to those implemented in the Pork GHG Project Builder Software™ ("Builder"), distributed by the Canadian Pork Council. Users of the Alberta Pork Protocol may choose to user the Builder to assess opportunities for creating offsets, or to complete the calculations of offsets. However, users must ensure that the assumptions and procedures of the "Builder" match the requirements of the Alberta Pork Protocol.

To demonstrate that a project meets the requirements under this protocol, the project proponent must supply sufficient evidence to demonstrate that:

1. All farms in the project are currently feeding swine (farrow, farrow to wean, farrow to finish, nursery, feeder operation) as confirmed by an affirmation from the project proponent;
2. All farms in the project are currently storing liquid manure for a minimum of 9 months as confirmed by an affirmation from the project proponent;
3. All farms in the project are currently applying manure or custom applying manure to land as confirmed by an affirmation from the project proponent;
4. All farms in the project can demonstrate a change in practice in at least one of the Feeding, or Storing and Spreading components of the Pork Protocol. The evidence for change in practice varies with the component of the Pork Protocol:
    - Feeding component — decreased N and/or VS content in the diets and/or decreased feed consumption per unit pigs sold relative to the project-specific or sector-level baseline. Decreased feed consumption per unit pigs raised may be achieved by a range of practices, including, but not limited to:
        - Split-sex or phase feeding;
        - Wet/dry feeders;
        - Improved ventilation/temperature control in the barn;
        - Improved health status of the swine herd;
        - More efficient genetics; or
        - Additives to improve feed efficiency.
    - Storing & Spreading component — change to spring or spring-and-fall emptying and spreading, where the baseline for all projects is set as fall emptying.
5. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol; and,

6. The project must meet the requirements for offset eligibility as specified in the applicable regulation and guidance documents for the Alberta Offset System.

Flexibility in applying the quantification protocol is provided to project developers in three ways:

1. A project proponent may choose to implement only one component, e.g. practices to reduce methane emissions from manure storage, but they would be required to perform the calculations for the other two components to ensure the net balance of GHG emissions is still positive. This must be shown in the project document;
2. If a farm has both solid and liquid swine manure systems, the feed for pig classes under liquid manure can be split out and applied to the Pork Protocol;
3. Site specific emission factors may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these emission factors must be sufficiently robust as to ensure reasonable accuracy; and
4. The Pork Protocol promotes a project-specific baseline (based on real historical data), but allows for selection of a sector-level baseline using regional data for feeding (Livestock Feed Requirements Study 2001). All proponents will use fall spreading as the baseline practice for the storage and spreading component of the Pork Protocol. The Quantification Plan of the Pork Protocol specifies the calculations to be used for each option. Farms that were not operating at the Eligibility Start Date (January 2001) may use their start-up feeding data as a project-specific baseline, or they may choose to use the sector-level feeding baseline to participate in Pork Protocol projects. All Baseline and Project calculations could be made using the Pork GHG Project Builder™ ("Builder") Software, with the condition that the user ensures the Builder is compatible with the Alberta Pork Protocol.

If applicable, the proponent must indicate and justify why flexibility provisions have been used.

This quantification protocol is written for the swine farm operator or project proponent. Some familiarity with, or general understanding of, the operation of a swine farming practices is expected.

## 1.2 Glossary of New Terms

| | |
|---|---|
| Emptying season | The time of year that the manure storage is agitated and emptied, and the manure applied to cropland. In most regions of Canada it is illegal to spread manure on frozen crop or forage lands during the late fall and throughout the winter season. Therefore, the emptying season for the majority of Canadian pig farms will be early spring prior to spring planting, throughout the summer on annual crops or perennial |

forage stands, or throughout the fall following the harvest of annual cereal grains and oilseeds.

Farrow-to-finish
A term used to describe a pig farm on which animals complete their entire life cycle, from birth to market.

Farrow-to-wean
Term used to describe a pig farm on which the main product is a 5-25kg pig. These young pigs, known as 'weaners' are sold off the farrow-to-wean farm to a finishing operation that would grow the weaners from 5-25 kg to an approximate slaughter market weight of 115 kg.

Feeder
The term for a pig which has reached a total weight of 25 kg or more and is in the final stages of development for a slaughter market. A feeder pig will be marketed at roughly 115 kg.

Feed Efficiency
For any swine enterprise, feed efficiency is calculated as the total weight of pigs sold divided by the total weight of feed used. In the Pork Protocol, increased feed efficiency (less feed needed to grow the same weight of pigs) is accepted as an indicator of increased energy efficiency.

Feed wastage
The amount of feed that is wasted by the pigs during the rearing period. Feed wastage usually occurs at the feeding station within the pen area. Feed can be wasted as a result of any number of management practice decisions. For example, if the feeding station is not properly adjusted so that animals have access to excessive quantities of feedstuff, rooting in the feed trough may result in excessive feed wastage, or if the feeders are not properly sized and the animals have to step into the feeder to access the feedstuff high levels of feed wastage can be expected.

Indoor deep pit
Indoor deep pit barns are constructed with deep basements to store liquid slurry that passes through a slatted floor system on which pigs are housed. Manure is not removed from these barns to an external storage on a regular basis. Manure is removed directly from these barns/manure storage structures when manure is being applied to cropland only. Deep pit barns require constant ventilation of the manure storage under the animals to avoid the

build-up of potentially lethal manure gases in the barn.

Nursery

A pig barn designed to house animals from the time they are weaned (about 5 kg) until they reach a sufficient age and weight (25 kg) to be moved into a finishing barn. Nurseries are specially designed to allow pigs need to develop immune responses before being transferred to a finishing facility.

Outdoor slurry

Outdoor slurry is used to describe a manure storage structure that is outside of the pig barn. Outdoor slurry containment systems generally consist of two types: a round concrete manure storage structure or a rectangular, earthen storage structure.

Phase feeding

Phase feeding is a management system where the composition of a finishing ration is altered throughout the finishing growth cycle to reflect the deceased requirement by the animals for crude protein. The result is a lower cost of finishing pigs to market weight as sources of crude protein such as soybean meal tend to be one of the more expensive feed ingredients. Additional benefits include reduced nitrogen output in urine and faeces when animals are fed closer to their crude protein requirement and are not required to pass excess nitrogen through their digestive systems. Flushing excess protein (nitrogen) is costly in metabolic energy and increases the amount of water consumed by finishing pigs, increasing the volume of slurry produced on the farm.

Split sex feeding

A management practice used to increase the feed efficiency of finishing hogs. Barrows and gilts (male and female feeder hogs) require slightly different mineral, protein and energy levels in their rations to achieve their genetic potential for efficient growth. By separating males and females (sexing) prior to the animals populating a feeder barn, it is possible to feed a male ration to the barrows and a female ration to the gilts corresponding to the individual needs of the two animal populations in order to achieve a high level of feed conversion efficiency.

Volatile solids

The undigested organic portion of feed that is excreted by pigs as manure and is potentially

available for conversion into methane during manure storage through natural microbiological processes. Non-volatile solids include any dirt, ash or other inorganic materials that may be contained in hog feed and cannot be converted to methane.

# 2.0 QUANTIFICATION DEVELOPMENT AND JUSTIFICATION

The following sections outline the quantification development and justification.

## 2.1 Identification of Sources and Sinks (SS's) for the Project

SS's were identified for the project by reviewing the seed protocol document and relevant process flow diagram. This process confirmed that the SS's in the process flow diagrams covered the full scope of eligible project activities under the protocol.

Based on the process flow diagrams provided in **FIGURE 1.1**, the project SS's were organized into life cycle categories in **FIGURE 2.1**. Descriptions of each of the SS's and their classification as controlled, related or affected are provided in **TABLE 2.1.**

**FIGURE 2.1: Project Element Life Cycle Chart**

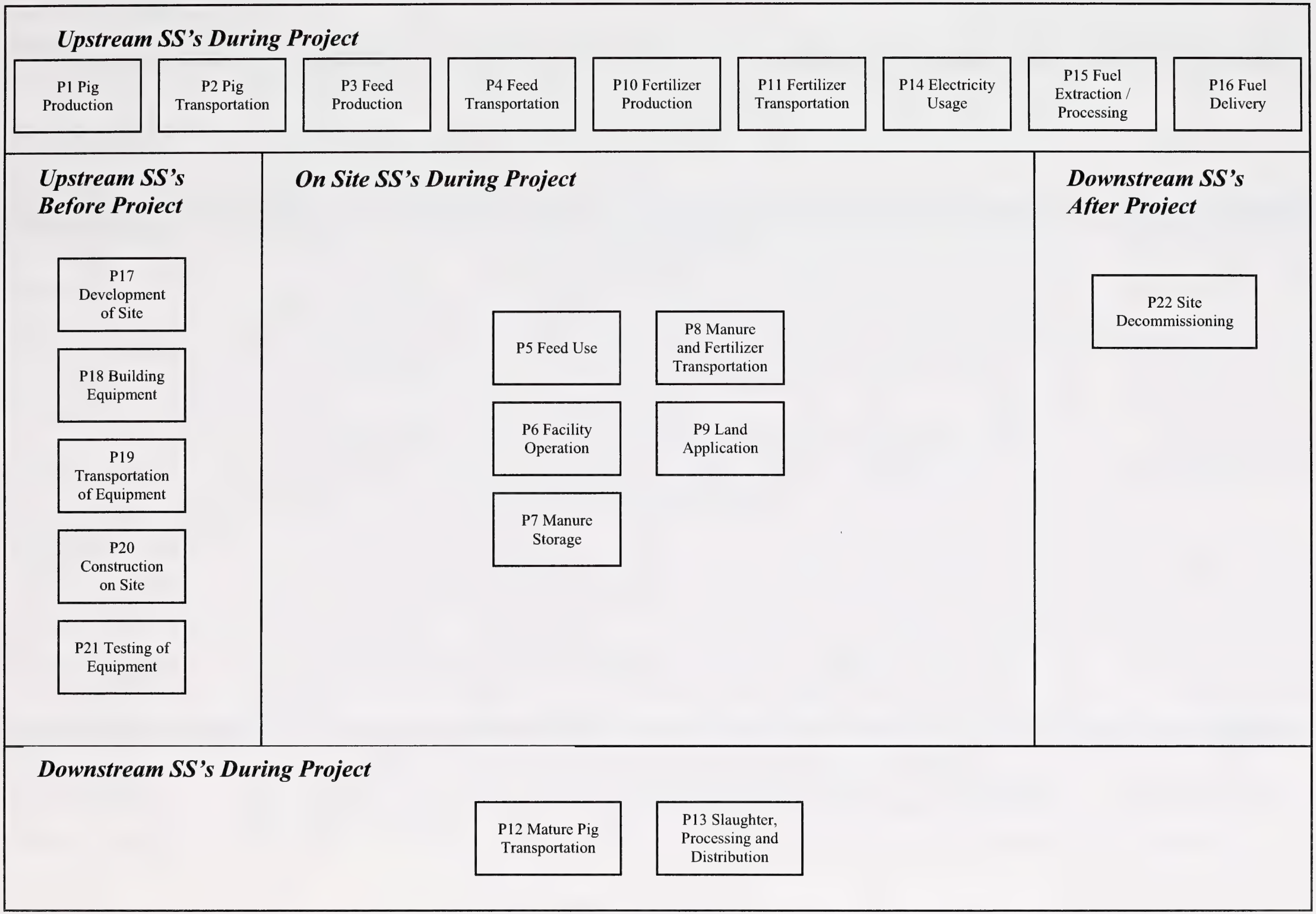


**TABLE 2.1: Project SS's**

| 1. SS | 2. Description | 3. Controlled, Related or Affected |
|---|---|---|
| **Upstream SS's during Project Operation** | | |
| P1 Pig Production | Pig production may include raising pigs that are input to the enterprise. This may require several energy inputs such as natural gas, diesel and electricity. Quantities and types for each of the energy inputs would be contemplated to evaluate functional equivalence with the baseline condition. | Related |
| P2 Pig Transportation | Pigs may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the baseline condition. | Related |
| P3 Feed Production | Feed may be produced from agricultural materials and amendments. The processing of the feed may include a number of chemical, mechanical and amendment processes. This requires several energy inputs such as natural gas, diesel and electricity. Quantities and types for each of the energy inputs would be contemplated to evaluate functional equivalence with the baseline condition. | Related |
| P4 Feed Transportation | Feed may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the baseline condition. | Related |
| P10 Fertilizer Production | Fertilizer may be produced through a number of chemical, mechanical and amendment processes. This requires several energy inputs such as natural gas, diesel and electricity. Quantities and types for each of the energy inputs would be contemplated and tracked to evaluate functional equivalence with the baseline condition. | Related |
| P11 Fertilizer Transportation | Fertilizer may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the baseline condition. | Related |
| P14 Electricity Usage | Electricity may be required for operating the facility. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions. | Related |

| | | |
|---|---|---|
| P15 Fuel Extraction and Processing | Each of the fuels used throughout the on-site component of the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the on-site SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked. | Related |
| P16 Fuel Delivery | Each of the fuels used throughout the on-site component of the project will need to be transported to the site. This may include shipments by tanker or by pipeline, resulting in the emissions of greenhouse gases. It is reasonable to exclude fuel sourced by taking equipment to an existing commercial fuelling station as the fuel used to take the equipment to the site is captured under other SS's and there is no other delivery. | Related |
| **Onsite SS's during Project Operation** | | |
| P5 Feed Use | Feed use includes two elements. The first is the management of the feed composition relative to the nitrogen and volatile solid excretions from the animals. The composition of feed would need to be tracked. The second is the mechanical and physical processes required to distribute the feed to the animals. Quantities for each of the energy inputs would be contemplated to evaluate functional equivalence with the baseline condition. | Controlled |
| P6 Facility Operation | Greenhouse gas emissions may occur that are associated with the operation and maintenance of the pig production facility operations. This may include running vehicles and facilities at the project site. Quantities and types for each of the energy inputs would be tracked. | Controlled |
| P7 Manure Storage | Greenhouse gas emissions can result from the operation of manure storage facilities. This will include emissions from energy use, and from the emissions of methane and nitrous oxide from the manure being stored. Quantities and types for each of the energy inputs would be tracked. Quantities, duration and conditions would also need to be tracked. | Controlled |
| P8 Manure and Fertilizer Transportation | Manure and fertilizer may need to be transported to the field for land application from storage. Transportation equipment would be fuelled by diesel, gas or natural gas. Quantities for each of the energy inputs would be contemplated to evaluate functional equivalence with the baseline condition. | Controlled |
| P9 Land Application | Manure and fertilizer will then be land applied. This will required the use of heavy equipment and mechanical systems. This equipment would be fuelled by diesel, gas, or natural gas resulting in GHG emissions. Other fuels may also be used in some rare cases. Quantities for each of the energy inputs would be contemplated to evaluate functional equivalence with the baseline condition. | Controlled |
| **Downstream SS's during Project Operation** | | |
| P12 Mature Pig Transportation | Pigs may be transported from the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would need to be tracked. | Related |

| | | |
|---|---|---|
| P13 Slaughter, Processing and Distribution | Greenhouse gas emissions may occur that are associated with the slaughter, processing and distribution components downstream of the pig production facility operations. This may include running vehicles and facilities at other sites. Quantities and types for each of the energy inputs would be tracked. | Related |
| **Other** | | |
| P17 Development of Site | The site of the facility may need to be developed. This could include civil infrastructure such as access to electricity, gas and water supply, as well as sewer etc. This may also include clearing, grading, building access roads, etc. There will also need to be some building of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons, etc., as well as structures to enclose, support and house the equipment. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site such as graders, backhoes, trenching machines, etc. | Related |
| P18 Building Equipment | Equipment may need to be built either on-site or off-site. This includes all of the components of the storage, handling, processing, combustion, air quality control, system control and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly. | Related |
| P19 Transportation of Equipment | Equipment built off-site and the materials to build equipment on-site, will all need to be delivered to the site. Transportation may be completed by train, truck, by some combination, or even by courier. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site. | Related |
| P20 Construction on Site | The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity. | Related |
| P21 Testing of Equipment | Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity. | Related |
| P22 Site Decommissioning | Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site. | Related |

## 2.2 Identification of Baseline

The baseline condition for projects applying this protocol are swine operations that were feeding swine, were storing liquid manure for a minimum of 9 months and/or are currently applying the manure to land. The baseline condition defines the operating conditions at the project farm prior to the change in either or both of the feeding and storage and spreading practises. The baseline for all projects is set as fall emptying as this represents typical industry practise.

The approach to quantifying the baseline will be primarily projection based as there are suitable models for the applicable baseline condition that can provide reasonable certainty. However, a performance standard based approach has been integrated for areas where data collection requirements may be impractical or uneconomic. The baseline scenario for this protocol is dynamic as the emissions profile for the baseline activities would be expected to change materially relative to the number of pigs at the project farm.

The baseline condition is defined, including the relevant SS's and processes, as shown in **FIGURE 1.2**. More detail on each of these SS's is provided in Section 2.3, below.

## 2.3 Identification of SS's for the Baseline

Based on the process flow diagrams provided in **FIGURE 1.2**, the project SS's were organized into life cycle categories in **FIGURE 2.2**. Descriptions of each of the SS's and their classification as either 'controlled', 'related' or 'affected' is provided in **TABLE 2.2.**

**FIGURE 2.2: Baseline Element Life Cycle Chart**

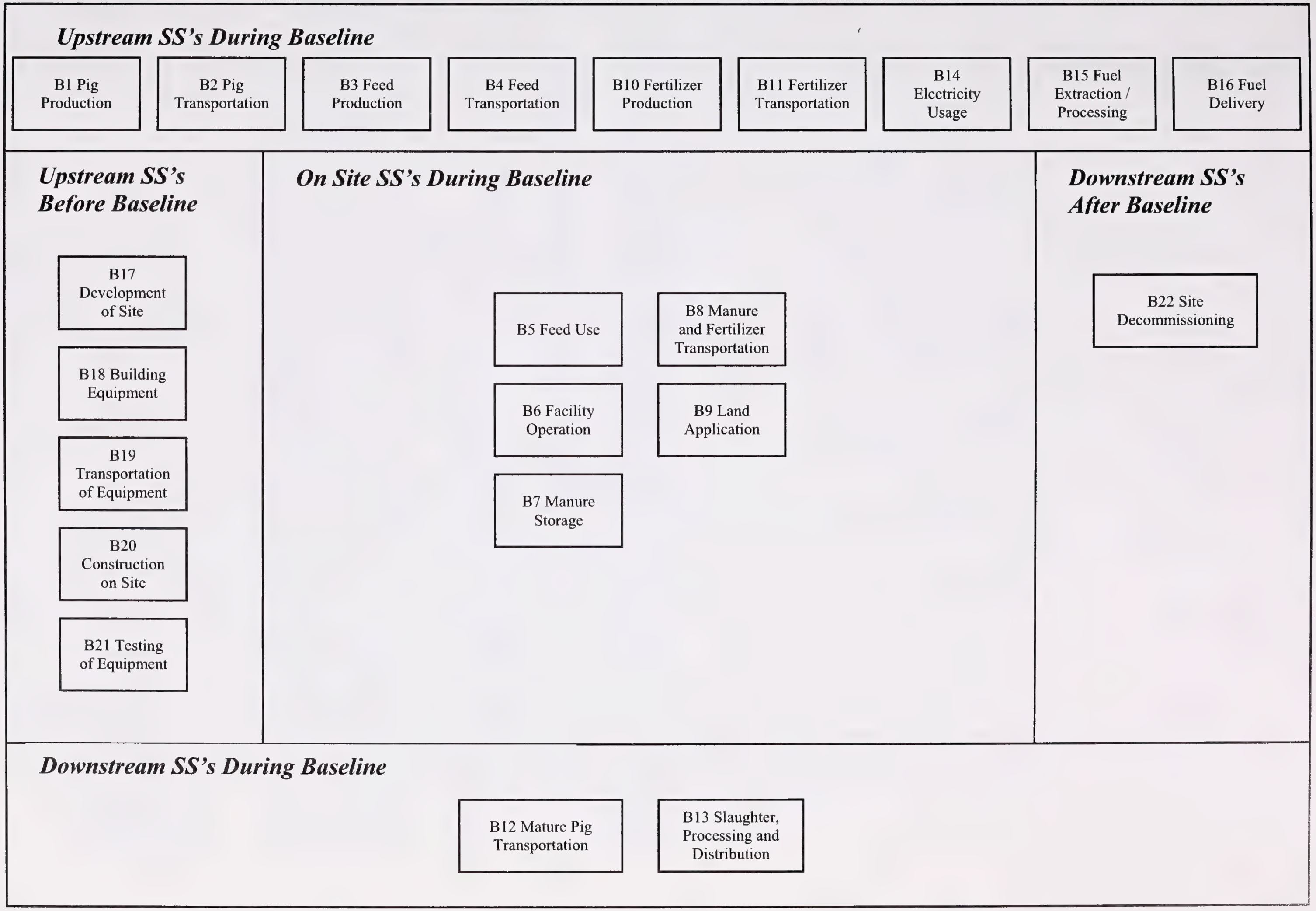


**TABLE 2.2: Baseline SS's**

| 1. SS | 2. Description | 3. Controlled, Related or Affected |
|---|---|---|
| **Upstream SS's during Baseline Operation** | | |
| B1 Pig Production | Pig production may include raising pigs, including semen, that are input to the enterprise. This may require several energy inputs such as natural gas, diesel and electricity. Quantities and types for each of the energy inputs would be contemplated to evaluate functional equivalence with the project condition. | Related |
| B2 Pig Transportation | Pigs may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the project condition. | Related |
| B3 Feed Production | Feed may be produced from agricultural materials and amendments. The processing of the feed may include a number of chemical, mechanical and amendment processes. This requires several energy inputs such as natural gas, diesel and electricity. Quantities and types for each of the energy inputs would be contemplated to evaluate functional equivalence with the project condition. | Related |
| B4 Feed Transportation | Feed may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the project condition. | Related |
| B10 Fertilizer Production | Fertilizer may be produced through a number of chemical, mechanical and amendment processes. This requires several energy inputs such as natural gas, diesel and electricity. Quantities and types for each of the energy inputs would e contemplated to evaluate functional equivalence with the project condition. | Related |
| B11 Fertilizer Transportation | Fertilizer may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the project condition. | Related |
| B14 Electricity Usage | Electricity may be required for operating the facility. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions. | Related |
| B15 Fuel Extraction and Processing | Each of the fuels used throughout the on-site component of the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the on-site SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked. | Related |

| | | |
|---|---|---|
| B16 Fuel Delivery | Each of the fuels used throughout the on-site component of the project will need to be transported to the site. This may include shipments by tanker or by pipeline, resulting in the emissions of greenhouse gases. It is reasonable to exclude fuel sourced by taking equipment to an existing commercial fuelling station as the fuel used to take the equipment to the site is captured under other SS's and there is no other delivery. | Related |
| **Onsite SS's during Baseline Operation** | | |
| B5 Feed Use | Feed use includes two elements. The first is the management of the feed composition relative to the nitrogen and volatile solid excretions from the animals. The composition of feed would need to be tracked. The second is the mechanical and physical processes required to distribute the feed to the animals. Quantities for each of the energy inputs would be contemplated to evaluate functional equivalence with the project condition. | Controlled |
| B6 Facility Operation | Greenhouse gas emissions may occur that are associated with the operation and maintenance of the pig production facility operations. This may include running vehicles and facilities at the project site. Quantities and types for each of the energy inputs would be tracked. | Controlled |
| B7 Manure Storage | Greenhouse gas emissions can result from the operation of manure storage facilities. This will include emissions from energy use, and from the emissions of methane and nitrous oxide from the manure being stored. Quantities and types for each of the energy inputs would be tracked. Quantities, duration and conditions would also need to be tracked. | Controlled |
| B8 Manure and Fertilizer Transportation | Manure and fertilizer may need to be transported to the field for land application from storage. Transportation equipment would be fuelled by diesel, gas or natural gas. Quantities for each of the energy inputs would be contemplated to evaluate functional equivalence with the project condition. | Controlled |
| B9 Land Application | Manure and fertilizer will then be land applied. This will required the use of heavy equipment and mechanical systems. This equipment would be fuelled by diesel, gas, or natural gas resulting in GHG emissions. Other fuels may also be used in some rare cases. Quantities for each of the energy inputs would be contemplated to evaluate functional equivalence with the project condition. | Controlled |
| **Downstream SS's during Baseline Operation** | | |
| B12 Mature Pig Transportation | Pigs may be transported from the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would need to be tracked. | Related |
| B13 Slaughter, Processing and Distribution | Greenhouse gas emissions may occur that are associated with the slaughter, processing and distribution components downstream of the pig production facility operations. This may include running vehicles and facilities at other sites. Quantities and types for each of the energy inputs would be tracked. | Related |

| **Other** | | |
|---|---|---|
| B17 Development of Site | The site of the facility may need to be developed. This could include civil infrastructure such as access to electricity, gas and water supply, as well as sewer etc. This may also include clearing, grading, building access roads, etc. There will also need to be some building of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons, etc., as well as structures to enclose, support and house the equipment. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site such as graders, backhoes, trenching machines, etc. | Related |
| B18 Building Equipment | Equipment may need to be built either on-site or off-site. This includes all of the components of the storage, handling, processing, combustion, air quality control, system control and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly. | Related |
| B19 Transportation of Equipment | Equipment built off-site and the materials to build equipment on-site, will all need to be delivered to the site. Transportation may be completed by train, truck, by some combination, or even by courier. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site. | Related |
| B20 Construction on Site | The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity. | Related |
| B21 Testing of Equipment | Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity. | Related |
| B22 Site Decommissioning | Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site. | Related |

## 2.4 Selection of Relevant Project and Baseline SS's

Each of the SS's from the project and baseline condition were compared and evaluated as to their relevancy using the guidance provided in Annex VI of the "Guide to Quantification Methodologies and Protocols: Draft", dated March 2006 (Environment Canada). The justification for the exclusion, or conditions upon which SS's may be excluded is provided below. All other SS's listed previously are included. This information is summarized in **TABLE 2.3**, below.

**TABLE 2.3: Comparison of SS's**

| 1. Identified SS | 2. Baseline (C, R, A) | 3. Project (C, R, A) | 4. Include or Exclude from Quantification | 5. Justification for Exclusion |
|---|---|---|---|---|
| **Upstream SS's** | | | | |
| P1 Pig Production | N/A | Related | Exclude | Excluded as pig production is not impacted by the implementation of the project and as such the baseline and project conditions will be functionally equivalent. |
| B1 Pig Production | Related | N/A | Exclude | |
| P2 Pig Transportation | N/A | Related | Exclude | Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario. |
| B2 Pig Transportation | Related | N/A | Exclude | |
| P3 Feed Production | N/A | Related | Exclude | Excluded as feed production is not materially impacted by the implementation of the project and as such the baseline and project conditions will be functionally equivalent. |
| B3 Feed Production | Related | N/A | Exclude | |
| P4 Feed Transportation | N/A | Related | Exclude | Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario. |
| B4 Feed Transportation | Related | N/A | Exclude | |
| P10 Fertilizer Production | N/A | Related | Exclude | Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations. |
| B10 Fertilizer Production | Related | N/A | Exclude | |
| P11 Fertilizer Transportation | N/A | Related | Exclude | Excluded as the emissions from transportation are negligible functionally equivalent to the baseline scenario. |
| B11 Fertilizer Transportation | Related | N/A | Exclude | |
| P14 Electricity Usage | N/A | Related | Exclude | Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations. |
| B14 Electricity Usage | Related | N/A | Exclude | |
| P15 Fuel Extraction and Processing | N/A | Related | Exclude | Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations. |
| B15 Fuel Extraction and Processing | Related | N/A | Exclude | |

| | | | | |
|---|---|---|---|---|
| P16 Fuel Delivery | N/A | Related | Exclude | Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations. |
| B16 Fuel Delivery | Related | N/A | Exclude | |
| **Onsite SS's** | | | | |
| P5 Feed Use | N/A | Controlled | Exclude | The impact of feed composition is realized in P7/B7 and while processes for distributing the feed are excluded as they are likely functionally equivalent to the baseline scenario. |
| B5 Feed Use | Controlled | N/A | Exclude | |
| P6 Facility Operation | N/A | Controlled | Exclude | Excluded as pig production is not impacted by the implementation of the project and as such the baseline and project conditions will be functionally equivalent. |
| B6 Facility Operation | Controlled | N/A | Exclude | |
| P7 Manure Storage | N/A | Controlled | Include | N/A |
| B7 Manure Storage | Controlled | N/A | Include | N/A |
| P8 Manure and Fertilizer Transportation | N/A | Controlled | Exclude | Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario. |
| B8 Manure and Fertilizer Transportation | Controlled | N/A | Exclude | |
| P9 Land Application | N/A | Controlled | Include | N/A |
| B9 Land Application | Controlled | N/A | Include | N/A |
| **Downstream SS's** | | | | |
| P12 Mature Pig Transportation | N/A | Related | Exclude | Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario. |
| B12 Mature Pig Transportation | Related | N/A | Exclude | |
| P13 Slaughter, Processing and Distribution | N/A | Related | Exclude | Excluded as the emissions from slaughter, processing and distribution are likely functionally equivalent to the baseline scenario. |
| B13 Slaughter, Processing and Distribution | Related | N/A | Exclude | |
| **Other** | | | | |
| P17 Development of Site | N/A | Related | Exclude | Emissions from site development are not material given the long project life, and the minimal site development typically required. |

| | | | | |
|---|---|---|---|---|
| B17 Development of Site | Related | N/A | Exclude | Emissions from site development are not material for the baseline condition given the minimal site development typically required. |
| P18 Building Equipment | N/A | Related | Exclude | Emissions from building equipment are not material given the long project life, and the minimal building equipment typically required. |
| B18 Building Equipment | Related | N/A | Exclude | Emissions from building equipment are not material for the baseline condition given the minimal building equipment typically required. |
| P19 Transportation of Equipment | N/A | Related | Exclude | Emissions from transportation of equipment are not material given the long project life, and the minimal transportation of equipment typically required. |
| B19 Transportation of Equipment | Related | N/A | Exclude | Emissions from transportation of equipment are not material for the baseline condition given the minimal transportation of equipment typically required. |
| P20 Construction on Site | N/A | Related | Exclude | Emissions from construction on site are not material given the long project life, and the minimal construction on site typically required. |
| B20 Construction on Site | Related | N/A | Exclude | Emissions from construction on site are not material for the baseline condition given the minimal construction on site typically required. |
| P21 Testing of Equipment | N/A | Related | Exclude | Emissions from testing of equipment are not material given the long project life, and the minimal testing of equipment typically required. |
| B21 Testing of Equipment | Related | N/A | Exclude | Emissions from testing of equipment are not material for the baseline condition given the minimal testing of equipment typically required. |
| P22 Site Decommissioning | N/A | Related | Exclude | Emissions from decommissioning are not material given the long project life, and the minimal decommissioning typically required. |
| B22 Site Decommissioning | Related | N/A | Exclude | Emissions from decommissioning are not material for the baseline condition given the minimal decommissioning typically required. |

## 2.5 Quantification of Reductions, Removals and Reversals of Relevant SS's

### 2.5.1 Quantification Approaches

Quantification of the reductions, removals and reversals of relevant SS's for each of the greenhouse gases will be completed using the methodologies outlined in **TABLE 2.4**, below. A listing of relevant emission factors is provided in **Appendix A**. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

$$\text{Emission Reduction} = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}$$

$$\begin{aligned}\text{Emissions}_{\text{Baseline}} = {} & \text{Emissions}_{\text{Methane}} + \text{Emissions}_{\text{Direct Nitrous Oxide}} \\ & + \text{Emissions}_{\text{Indirect Volatization Nitrous Oxide}} \\ & + \text{Emissions}_{\text{Indirect Leachate Nitrous Oxide}}\end{aligned}$$

$$\begin{aligned}\text{Emissions}_{\text{Project}} = {} & \text{Emissions}_{\text{Methane}} + \text{Emissions}_{\text{Direct Nitrous Oxide}} \\ & + \text{Emissions}_{\text{Indirect Volatization Nitrous Oxide}} \\ & + \text{Emissions}_{\text{Indirect Leachate Nitrous Oxide}}\end{aligned}$$

Where:

$\text{Emissions}_{\text{Baseline}}$ = sum of the emissions under the baseline condition.

- $\text{Emissions}_{\text{Methane}}$ = emissions under SS B7 Manure Storage
- $\text{Emissions}_{\text{Direct Nitrous Oxide}}$ = component of emissions under SS B9 Land Application
- $\text{Emissions}_{\text{Indirect Volatilization Nitrous Oxide}}$ = component of emissions under SS B9 Land Application
- $\text{Emissions}_{\text{Indirect Leachate Nitrous Oxide}}$ = component of emissions under SS B9 Land Application

$\text{Emissions}_{\text{Project}}$ = sum of the emissions under the project condition.

- $\text{Emissions}_{\text{Methane}}$ = emissions under SS P7 Manure Storage
- $\text{Emissions}_{\text{Direct Nitrous Oxide}}$ = component of emissions under SS P9 Land Application
- $\text{Emissions}_{\text{Indirect Volatilization Nitrous Oxide}}$ = component of emissions under SS P9 Land Application
- $\text{Emissions}_{\text{Indirect Leachate Nitrous Oxide}}$ = component of emissions under SS P9 Land Application

**TABLE 2.4: Quantification Procedures**

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justify measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| **Project SS's** | | | | | | |
| P7 Manure Storage | $VS_{Pig\ Class\ i} = FI_{Pig\ Class\ i} * (DM_{Pig\ Class\ i} - Ash_{Pig\ Class\ i}) / 100 * (1 - ED_{Pig\ Class\ i}) / 100$ or $VS_{Pig\ Class\ i} = Population_{Pig\ Class\ i} * Frac\ VS\ Excreted_{Pig\ Class\ i} / 100 * DFI_{Pig\ Class\ i} * Days_{Month}$ | | | | | |
| | Volatile Solids Excreted Monthly per Pig Class / $VS_{Pig\ Class\ i}$ | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Total Feed Intake per Month per Pig Class / $FI_{Pig\ Class\ i}$ | Mg | Measured | Recorded by the project proponent as the mass of feed, as-fed basis, purchased for pig class i each month. | Monthly | Readily available data provides sufficient accuracy. |
| | Percentage of Dry Matter in Feed for the Month per Pig Class / $DM_{Pig\ Class\ i}$ | % | Measured | Recorded by the project proponent based on the feed purchased for pig class i each month. | Monthly | Representative data from actual feed. |
| | Percentage of Ash Content in Feed for the Month per Pig Class / $Ash_{Pig\ Class\ i}$ | % | Measured | Recorded by the project proponent based on the feed purchased for pig class i each month. | Monthly | Representative data from actual feed. |
| | Energy Digestibility for Feed for the Month per Pig Class / $ED_{Pig\ Class\ i}$ | % | Estimated | Calculated for diet ingredients using the Noblet database numbers in Appendix A. | Monthly | Based on monthly feed rations as direct testing is infeasible. |
| | Population of Pigs for the Month per Pig Class / $Population_{Pig\ Class\ i}$ | head | Measured | Recorded by the project proponent based on the number of pigs for pig class i each month. | Monthly | Monthly counts match with other data frequencies. |

| | | | | | | |
|---|---|---|---|---|---|---|
| P7 Manure Storage (Continued) | Fraction of Volatile Solids Excreted Due to Feed for the Month per Pig Class / Frac VS Excreted $_{Pig\ Class\ i}$ | % | Estimated | Calculated for diet ingredients using the Noblet database numbers in Appendix A. | Monthly | Use of database on monthly basis guided by ash, dry matter and energy digestibility data. |
| | Daily Feed Consumption per Pig Class / DFI $_{Pig\ Class\ i}$ | Mg / head / d | Estimated | Performance standard. | Monthly | Values range, but an average value is representative. |
| | Days Month | d | Measured | Constant | Monthly | From calendar. |
| | VS Load = VS $_{Monthly\ Total}$ * MDP | | | | | |
| | Monthly Loading of Volatile Solids / VS Load | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Monthly Total of Volatile Excreted Summed across Pig Classes / VS $_{Monthly\ Total}$ | Mg | Measured | Calculated by summing the volatile solids from all pig classes on the farm each month. | Monthly | Sum of previously calculated results per pig class on monthly basis. |
| | Storage Characteristic Adjustment Factor / SCA | - | Estimated | Factor set at 0.45 pending further scientific analysis. | Annually | As per NCGAVS process. |
| | VS Available = VS Load + [VS Available $_{Last\ Month}$ - VS Converted $_{Last\ Month}$] | | | | | |
| | Available Volatile Solids for the Month / VS Available | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Available Volatile Solids for the Previous Month / VS Available $_{Last\ Month}$ | Mg | Measured | This represents the accumulated volatile solids at the end of the previous month. After emptying, the accumulated volatile solids equals 0. | Monthly | As per NCGAVS process. |

| | | | | | | |
|---|---|---|---|---|---|---|
| P7 Manure Storage (Continued) | Volatile Solids Converted to Methane for the Previous Month / VS Converted $_{Last\ Month}$ | Mg | Measured | The amount of volatile solids converted to methane in the previous month is calculated by multiplying the amount of volatile solids by the climate factor (*f*). | Monthly | As per NCGAVS process. |
| | $f = \exp[(E_{Activation} * (T_{Average} - T_{Standard})) / (R_{Gas\ Constant} * T_{Average} * T_{Standard})]$ | | | | | |
| | Monthly Climate Factor / *f* | - | N/A | N/A | N/A | Quantity being calculated. |
| | Activation Energy Constant / E $_{Activation}$ | cal / mol | Estimated | Constant set at 15,175 cal / mol | Annually | As per NCGAVS process. |
| | Ideal Gas Constant / R $_{Gas\ Constant}$ | cal * ºK / mol | Estimated | Constant set at 1.987 cal * ºK / mol | Annually | As per NCGAVS process. |
| | Standard Temperature | ºK | Estimated | Constant set at 303.16 ºK | Annually | As per NCGAVS process. |
| | Average Monthly Temperature | ºK | Measured | Monthly average as reported for region from nearest Environment Canada weather reporting station. | Monthly | Use of nearest Environment Canada weather reporting station is reasonable. |
| | $Emissions_{Methane} = \sum [VS_{Available\ month\ i} * f_{month\ i} * B_o]$ | | | | | |
| | Emissions $_{Methane}$ | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Maximum Methane Production Capacity / $B_o$ | - | Estimated | Factor set at 0.45 for liquid swine manure. | Annually | As per NCGAVS process. |
| P9 Land Application | $Nitrogen\ Available_{Pig\ Class\ i} = [(Nitrogen\ in\ Feed_{Pig\ Class\ i} / 100) * Mass\ of\ Feed_{Pig\ Class\ i}] - \{[(Nitrogen\ in\ Pigs\ Sold_{Pig\ Class\ i} / 100) * Mass\ of\ Pigs\ Sold_{Pig\ Class\ i}] - [(Nitrogen\ in\ Pigs\ Purchased_{Pig\ Class\ i} / 100) * Mass\ of\ Pigs\ Purchased_{Pig\ Class\ i}]\}$ | | | | | |
| | Nitrogen Available to Volatize from Pig Class i / Nitrogen Available $_{Pig\ Class\ i}$ | Mg / Event | N/A | N/A | N/A | Quantity being calculated. |

| | | | | | | |
|---|---|---|---|---|---|---|
| P9 Land Application (Continued) | Concentration of Nitrogen in Feed for Pig Class i / Nitrogen in Feed $_{\text{Pig Class i}}$ | % | Estimated | Recorded by the project proponent based on the feed purchased for pig class i each month. | Monthly | Industry tables provide reasonable approximation. |
| | Mass of Feed for Pig Class i / Mass of Feed $_{\text{Pig Class i}}$ | Mg / Event | Measured | Calculated either in bulk or as the product of the population in the pig class, the number of days and the ration per day per head. | Monthly | Values range, but an average value is representative. |
| | Concentration of Nitrogen in Pigs Sold from Pig Class i / Nitrogen in Pigs Sold $_{\text{Pig Class i}}$ | % | Estimated | Default factor derived from 'Manflow' model as 2.5% (0.025 kg N / kg pig). | Monthly | Derived from the 'Manflow' model. |
| | Mass of Pigs Sold from Pig Class i / Mass of Pigs Sold $_{\text{Pig Class i}}$ | Mg / Event | Measured | Recorded by the project proponent from sales records. | Monthly | Readily available data provides sufficient accuracy. |
| | Concentration of Nitrogen in Pigs Purchased into Pig Class i / Nitrogen in Pigs Purchased $_{\text{Pig Class i}}$ | % | Estimated | Default factor derived from 'Manflow' model as 2.5% (0.025 kg N / kg pig). | Monthly | Derived from the 'Manflow' model. |
| | Mass of Pigs Purchased from Pig Class i / Mass of Pigs Purchased $_{\text{Pig Class i}}$ | Mg / Event | Measured | Recorded by the project proponent from purchase records. | Monthly | Readily available data provides sufficient accuracy. |
| | $\text{Nitrogen}_{\text{Manure}} = \sum [\text{Nitrogen Available}_{\text{Monthly Total}} * (1 - \text{Volatilization Rate})]$ | | | | | |
| | Nitrogen in Manure at Event / Nitrogen $_{\text{Manure}}$ | Mg / Event | N/A | N/A | N/A | Quantity being calculated. |

| | | | | | | |
|---|---|---|---|---|---|---|
| P9 Land Application (Continued) | Monthly Total of Nitrogen Available Across Pig Classes / Nitrogen Available $_{Monthly\ Total}$ | Mg | Measured | Calculated above. | Monthly | Sum of previously calculated results per pig class on monthly basis. |
| | Volatilization Rate | - | Estimated | Factor set at 0.48. | Annual | |
| | $Emissions_{Direct\ Nitrous\ Oxide} = \sum [Nitrogen_{Manure} * Emission\ Factor_{Evap\ to\ Precip} * Ratio\ Factor_{Thaw} * Ratio\ Factor_{Season}]$ | | | | | |
| | Direct Emissions of Nitrous Oxide from Manure Spread Across Events / Emissions $_{Direct\ Nitrous\ Oxide}$ | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Emission Factor Adjusted According to Ratio of Potential Evaporation to Precipitation / Emission Factor $_{Evap\ to\ Precip}$ | - | Estimated | Default factor based on project farm. Factors listed in Appendix A | Annually | As per NCGAVS process. |
| | Ratio Factor to Correct for Emissions During Snow-Covered Periods / Ratio Factor $_{Thaw}$ | - | Estimated | Default factor based on location of project farm. For project farms located in Ontario, Quebec and Atlantic Canada, Ratio Factor $_{Thaw}$ = 1.4. For all other agricultural areas of Canada, Ratio Factor $_{Thaw}$ = 1.0. | Annually | As per NCGAVS process. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Ratio Factor to Account for Season of Manure Application / Ratio Factor $_{Season}$ | - | Estimated | The default ratio for application of manure after August (fall) = 1.20, while that for application before August (spring) = 1.00 | Annually | Industry tables provide reasonable approximation. |
| P9 Land Application (Continued) | Emissions $_{Indirect\ Volatilization\ Nitrous\ Oxide}$ = ∑ [Nitrogen Available $_{Monthly\ Total}$ * Volatilization Rate * Emission Factor $_{Volatilization}$] | | | | | |
| | Indirect Emissions of Nitrous Oxide from Volatilization and Redeposition of $NH_3$ and NOx / Emissions $_{Indirect\ Volatilization\ Nitrous\ Oxide}$ | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Emission Factor for $N_2O$ from Nitrogen Redeposited after Volatilization / Emission Factor $_{Volatilization}$ | kg $N_20$ - N / kg N | Estimated | Default factor set at 0.01 kg $N_2O$ - N / kg N | Annually | As per NCGAVS process. |
| | Emissions $_{Indirect\ Leachate\ Nitrous\ Oxide}$ = ∑ [Nitrogen $_{Manure}$ * Fraction $_{Leachate}$ * Emission Factor $_{Leachate}$] | | | | | |
| | Indirect Emissions of Nitrous Oxide from Volatilization and Leachate / Emissions $_{Indirect\ Leachate\ Nitrous\ Oxide}$ | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Fraction of Nitrogen Lost in Leachate / Fraction $_{Leachate}$ | - | Estimated | Calculated as 0.3165 * ratio of precipitation to potential evaporation - 0.0165 | Monthly | As per NCGAVS process. Use of nearest Environment Canada weather reporting station data for precipitation and evaporation, or use of regional climatic information, is reasonable. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Emission Factor for $N_2O$ from Leachate / Emission Factor $_{Leachate}$ | kg $N_20$ - N / kg N | Default | Default factor set at 0.0125 kg $N_2O$ - N / kg N | Annually | As per NCGAVS process. |
| **Baseline SS's** | | | | | | |
| B7 Manure Storage | $VS_{Pig\ Class\ i} = FI_{Pig\ Class\ i} * (DM_{Pig\ Class\ i} - Ash_{Pig\ Class\ i}) / 100 * (1 - ED_{Pig\ Class\ i}) / 100$ or $VS_{Pig\ Class\ i} = Population_{Pig\ Class\ i} * Frac\ VS\ Excreted_{Pig\ Class\ i} / 100 * DFI_{Pig\ Class\ i} * Days_{Month}$ | | | | | |
| | Volatile Solids Excreted Monthly per Pig Class / $VS_{Pig\ Class\ i}$ | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Total Feed Intake per Month per Pig Class / $FI_{Pig\ Class\ i}$ | Mg | Measured | Recorded by the project proponent as the mass of feed, as fed basis, purchased for pig class i each month. | Monthly | Readily available data provides sufficient accuracy. |
| | Percentage of Dry Matter in Feed for the Month per Pig Class / $DM_{Pig\ Class\ i}$ | % | Measured | Recorded by the project proponent based on the feed purchased for pig class i each month. | Monthly | Representative data from actual feed. |
| | Percentage of Ash Content in Feed for the Month per Pig Class / $Ash_{Pig\ Class\ i}$ | % | Measured | Recorded by the project proponent based on the feed purchased for pig class i each month. | Monthly | Representative data from actual feed. |
| | Energy Digestibility for Feed for the Month per Pig Class / $ED_{Pig\ Class\ i}$ | % | Estimated | Calculated for diet ingredients using the Noblet database numbers in Appendix A. | Monthly | Based on monthly feed rations as direct testing is infeasible. |
| | Population of Pigs for the Month per Pig Class / $Population_{Pig\ Class\ i}$ | head | Measured | Recorded by the project proponent based on the number of pigs for pig class i each month. | Monthly | Monthly counts match with other data frequencies. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Fraction of Volatile Solids Excreted Due to Feed for the Month per Pig Class / Frac VS Excreted $_{Pig\ Class\ i}$ | % | Estimated | Calculated for diet ingredients using the Noblet database numbers in Appendix A. | Monthly | Use of database on monthly basis guided by ash, dry matter and energy digestibility data. |
| B7 Manure Storage (Continued) | Daily Feed Consumption per Pig Class / DFI $_{Pig\ Class\ i}$ | Mg / head / d | Estimated | Performance standard provided. | Monthly | Values range, but an average value is representative. |
| | Days Month | d | Measured | Constant | Monthly | From calendar. |
| | VS Load = VS $_{Monthly\ Total}$ * MDP | | | | | |
| | Monthly Loading of Volatile Solids / VS Load | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Monthly Total of Volatile Excreted Summed across Pig Classes / VS $_{Monthly\ Total}$ | Mg | Measured | Calculated by summing the volatile solids from all pig classes on the farm each month. | Monthly | Sum of previously calculated results per pig class on monthly basis. |
| | Storage Characteristic Adjustment Factor / SCA | - | Estimated | Factor set at 0.45 pending further scientific analysis. | Annually | As per NCGAVS process. |
| | VS Available = VS Load + [VS Available $_{Last\ Month}$ - VS Converted $_{Last\ Month}$] | | | | | |
| | Available Volatile Solids for the Month / VS Available | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Available Volatile Solids for the Previous Month / VS Available $_{Last\ Month}$ | Mg | Measured | This represents the accumulated volatile solids at the end of the previous month. After emptying, the accumulated volatile solids equals 0. | Monthly | As per NCGAVS process. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Volatile Solids Converted to Methane for the Previous Month / $VS\ Converted_{Last\ Month}$ | Mg | Measured | The amount of volatile solids converted to methane in the previous month is calculated by multiplying the amount of volatile solids by the climate factor (*f*). | Monthly | As per NCGAVS process. |
| B7 Manure Storage (Continued) | $f = \exp[(E_{Activation} * (T_{Average} - T_{Standard})) / (R_{Gas\ Constant} * T_{Average} * T_{Standard})]$ | | | | | |
| | Monthly Climate Factor / *f* | - | N/A | N/A | N/A | Quantity being calculated. |
| | Activation Energy Constant / $E_{Activation}$ | cal / mol | Estimated | Constant set at 15,175 cal / mol | Annually | As per NCGAVS process. |
| | Ideal Gas Constant / $R_{Gas\ Constant}$ | cal * ºK / mol | Estimated | Constant set at 1.987 cal * ºK / mol | Annually | As per NCGAVS process. |
| | Standard Temperature | ºK | Estimated | Constant set at 303.16 ºK | Annually | As per NCGAVS process. |
| | Average Monthly Temperature | ºK | Measured | Monthly average as reported for region from nearest Environment Canada weather reporting station. | Monthly | Use of nearest Environment Canada weather reporting station is reasonable. |
| | $Emissions_{Methane} = \sum [VS_{Available\ month\ i} * f_{month\ i} * B_o]$ | | | | | |
| | $Emissions_{Methane}$ | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Maximum Methane Production Capacity / $B_o$ | - | Estimated | Factor set at 0.45 for liquid swine manure. | Annually | As per NCGAVS process. |
| B9 Land Application | $Nitrogen\ Available_{Pig\ Class\ i} = [(Nitrogen\ in\ Feed_{Pig\ Class\ i} / 100) * Mass\ of\ Feed_{Pig\ Class\ i}] - \{[(Nitrogen\ in\ Pigs\ Sold_{Pig\ Class\ i} / 100) * Mass\ of\ Pigs\ Sold_{Pig\ Class\ i}] - [(Nitrogen\ in\ Pigs\ Purchased_{Pig\ Class\ i} / 100) * Mass\ of\ Pigs\ Purchased_{Pig\ Class\ i}]\}$ | | | | | |
| | Nitrogen Available to Volatize from Pig Class i / $Nitrogen\ Available_{Pig\ Class\ i}$ | Mg / Event | N/A | N/A | N/A | Quantity being calculated. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Concentration of Nitrogen in Feed for Pig Class i / Nitrogen in Feed $_{Pig\ Class\ i}$ | % | Estimated | Recorded by the project proponent based on the feed purchased for pig class i each month. | Monthly | Industry tables provide reasonable approximation. |
| B9 Land Application (Continued) | Mass of Feed for Pig Class i / Mass of Feed $_{Pig\ Class\ i}$ | Mg / Event | Measured | Calculated either in bulk or as the product of the population in the pig class, the number of days and the ration per day her head. | Monthly | Values range, but an average value is representative. |
| | Concentration of Nitrogen in Pigs Sold from Pig Class i / Nitrogen in Pigs Sold $_{Pig\ Class\ i}$ | % | Estimated | Default factor derived from 'Manflow' model as 2.5% (O.025 kg N / kg pig). | Monthly | Derived from the 'Manflow' model. |
| | Mass of Pigs Sold from Pig Class i / Mass of Pigs Sold $_{Pig\ Class\ i}$ | Mg / Event | Measured | Recorded by the project proponent from sales records. | Monthly | Readily available data provides sufficient accuracy. |
| | Concentration of Nitrogen in Pigs Purchased into Pig Class i / Nitrogen in Pigs Purchased $_{Pig\ Class\ i}$ | % | Estimated | Default factor derived from 'Manflow' model as 2.5% (O.025 kg N / kg pig). | Monthly | Derived from the 'Manflow' model. |
| | Mass of Pigs Purchased from Pig Class i / Mass of Pigs Purchased $_{Pig\ Class\ i}$ | Mg / Event | Measured | Recorded by the project proponent from purchase records. | Monthly | Readily available data provides sufficient accuracy. |
| | $\text{Nitrogen}_{Manure} = \sum [\text{Nitrogen Available}_{Monthly\ Total} * (1 - \text{Volatilization Rate})]$ | | | | | |
| | Nitrogen in Manure at Event / Emissions $_{Nitrous\ Oxide}$ | Mg / Event | N/A | N/A | N/A | Quantity being calculated. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Monthly Total of Nitrogen Available Across Pig Classes / Nitrogen Available $_{Monthly\ Total}$ | Mg | Measured | Calculated above. | Monthly | Sum of previously calculated results per pig class on monthly basis. |
| B9 Land Application (Continued) | Volatilization Rate | - | Estimated | Factor set at 0.48. | Annual | |
| | $Emissions_{Direct\ Nitrous\ Oxide} = \sum [Nitrogen_{Manure} * Emission\ Factor_{Evap\ to\ Precip} * Ratio\ Factor_{Thaw} * Ratio\ Factor_{Season}]$ | | | | | |
| | Direct Emissions of Nitrous Oxide from Manure Spread Across Events / Emissions $_{Direct\ Nitrous\ Oxide}$ | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Emission Factor Adjusted According to Ratio of Potential Evaporation to Precipitation / Emission Factor $_{Evap\ to\ Precip}$ | - | Estimated | Default factor based on project farm. | Annually | As per NCGAVS process. |
| | Ratio Factor to Correct for Emissions During Snow-Covered Periods / Ratio Factor $_{Thaw}$ | - | Estimated | Default factor based on location of project farm. For project farms located in Ontario, Quebec and Atlantic Canada, Ratio Factor $_{Thaw}$ = 1.4. For all other agricultural areas of Canada, Ratio Factor $_{Thaw}$ = 1.0. | Annually | As per NCGAVS process. |
| | Ratio Factor to Account for Season of Manure Application / Ratio Factor $_{Season}$ | - | Estimated | The default ratio for application of manure after August (fall) = 1.20, while that for application before August (spring) = 1.00 | Annually | Industry tables provide reasonable approximation. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | $Emissions_{Indirect\ Volatilization\ Nitrous\ Oxide} = \sum [Nitrogen\ Available_{Monthly\ Total} * Volatilization\ Rate * Emission\ Factor_{Volatilization}]$ | | | | | |
| | Indirect Emissions of Nitrous Oxide from Volatilization and Redeposition of $NH_3$ and NOx / $Emissions_{Indirect\ Volatilization\ Nitrous\ Oxide}$ | Mg | N/A | N/A | N/A | Quantity being calculated. |
| B9 Land Application (Continued) | Emission Factor for $N_2O$ from Nitrogen Redeposited after Volatilization / $Emission\ Factor_{Volatilization}$ | kg $N_20$ - N / kg N | Estimated | Default factor set at 0.01 kg $N_2O$ - N / kg N | Annually | As per NCGAVS process. |
| | $Emissions_{Indirect\ Leachate\ Nitrous\ Oxide} = \sum [Nitrogen_{Manure} * Fraction_{Leachate} * Emission\ Factor_{Leachate}]$ | | | | | |
| | Indirect Emissions of Nitrous Oxide from Volatilization and Leachate / $Emissions_{Indirect\ Leachate\ Nitrous\ Oxide}$ | Mg | N/A | N/A | N/A | Quantity being calculated. |
| | Fraction of Nitrogen Lost in Leachate / $Fraction_{Leachate}$ | - | Estimated | Calculated as 0.3165 * ratio of precipitation to potential evaporation - 0.0165 | Monthly | As per NCGAVS process. Use of nearest Environment Canada weather reporting station data for precipitation and evaporation, or use of regional climatic information, is reasonable. |
| | Emission Factor for $N_2O$ from Leachate / $Emission\ Factor_{Leachate}$ | kg $N_20$ - N / kg N | Default | Default factor set at 0.0125 kg $N_2O$ - N / kg N | Annually | As per NCGAVS process. |

### 2.5.2. Contingent Data Approaches

Contingent means for calculating or estimating the required data for the equations outlined in section 2.5.1 are summarized in **TABLE 2.5**, below.

## 2.6 Management of Data Quality

In general, data quality management must include sufficient data capture such that the mass and energy balances may be easily performed with the need for minimal assumptions and use of contingency procedures. The data should be of sufficient quality to fulfill the quantification requirements and be substantiated by company records for the purpose of verification.

The project proponent shall establish and apply quality management procedures to manage data and information. Written procedures should be established for each measurement task outlining responsibility, timing and record location requirements. The greater the rigour of the management system for the data, the more easily an audit will be to conduct for the project.

### 2.6.1 Record Keeping

Record keeping practises should include:

a. Electronic recording of values of logged primary parameters for each measurement interval;
b. Printing of monthly back-up hard copies of all logged data;
c. Written logs of operations and maintenance of the project system including notation of all shut-downs, start-ups and process adjustments;
d. Retention of copies of logs and all logged data for a period of 7 years; and
e. Keeping all records available for review by a verification body.

### 2.6.1 Quality Assurance/Quality Control (QA/QC)

QA/QC can also be applied to add confidence that all measurements and calculations have been made correctly. These include, but are not limited to:

a Protecting monitoring equipment (sealed meters and data loggers);
b Protecting records of monitored data (hard copy and electronic storage);
c Checking data integrity on a regular and periodic basis (manual assessment, comparing redundant metered data, and detection of outstanding data/records);
d Comparing current estimates with previous estimates as a 'reality check';
e Provide sufficient training to operators to perform maintenance and calibration of monitoring devices;
f Establish minimum experience and requirements for operators in charge of project and monitoring; and
g Performing recalculations to make sure no mathematical errors have been made.

**TABLE 2.5: Contingent Data Collection Procedures**

| 1.0 Project / Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Contingency Method | 6. Frequency | 7. Justify measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| **Project SS's** | | | | | | |
| P7 Manure Storage | Total Feed Intake per Month per Pig Class / $FI_{\text{Pig Class } i}$ | Mg | Estimated | Average intake per head for the year multiplied by number of head in that month. | Monthly | Readily available data provides sufficient accuracy. |
| | Population of Pigs for the Month per Pig Class / $Population_{\text{Pig Class } i}$ | head | Estimated | Population in previous month minus pigs sold plus pigs purchased within that pig class | Monthly | Monthly counts match with other data frequencies. |
| | Average Monthly Temperature | °K | Estimated | Monthly average as reported for region from the closest Environment Canada weather reporting station. | Monthly | Use of nearest Environment Canada weather reporting station is reasonable. |
| P9 Land Application | Mass of Feed for Pig Class i / Mass of $Feed_{\text{Pig Class } i}$ | Mg / Event | Estimated | Average intake per head for the year multiplied by number of head in that month. | Monthly | Values range, but an average value is representative. |
| | Mass of Pigs Sold from Pig Class i / Mass of Pigs $Sold_{\text{Pig Class } i}$ | Mg / Event | Estimated | Estimates from sales records. | Monthly | Readily available data provides sufficient accuracy. |
| | Mass of Pigs Purchased from Pig Class i / Mass of Pigs $Purchased_{\text{Pig Class } i}$ | Mg / Event | Estimated | Estimates from purchase records. | Monthly | Readily available data provides sufficient accuracy. |
| **Baseline SS's** | | | | | | |
| B7 Manure Storage | Total Feed Intake per Month per Pig Class / $FI_{\text{Pig Class } i}$ | Mg | Estimated | Average intake per head for the year multiplied by number of head in that month. | Monthly | Readily available data provides sufficient accuracy. |

| | | | | | | |
|---|---|---|---|---|---|---|
| B7 Manure Storage | Population of Pigs for the Month per Pig Class / Population $_{\text{Pig Class i}}$ | head | Estimated | Population in previous month minus pigs sold plus pigs purchased within that pig class | Monthly | Monthly counts match with other data frequencies. |
| | Average Monthly Temperature | °K | Estimated | Monthly average as reported for region from the closest Environment Canada weather reporting station. | Monthly | Use of nearest Environment Canada weather reporting station is reasonable. |
| B9 Land Application | Mass of Feed for Pig Class i / Mass of Feed $_{\text{Pig Class i}}$ | Mg / Event | Estimated | Average intake per head for the year multiplied by number of head in that month. | Monthly | Values range, but an average value is representative. |
| | Mass of Pigs Sold from Pig Class i / Mass of Pigs Sold $_{\text{Pig Class i}}$ | Mg / Event | Estimated | Estimates from sales records. | Monthly | Readily available data provides sufficient accuracy. |
| | Mass of Pigs Purchased from Pig Class i / Mass of Pigs Purchased $_{\text{Pig Class i}}$ | Mg / Event | Estimated | Estimates from purchase records. | Monthly | Readily available data provides sufficient accuracy. |

# APPENDIX A:
## Relevant Emission Factor

**TABLE A.1: Gross Energy Digestibility and Fraction of Volatile Solids Excreted for feed ingredients based on the Noblet database.**

| | | CVB DM[a] (%) | CVB Ash[a] (% as is) | Calculation OM[b] (% as is) | Noblet GE dig[c] GF | Noblet GE dig[c] Sow | Calculation VS GF[d] (% as is) | Calculation VS Sow[d] (% as is) |
|---|---|---|---|---|---|---|---|---|
| **Ingredient** | **Emissions Factor:** | | | | ED $_{Pig\ Class\ i}$ | ED $_{Pig\ Class\ i}$ | Frac VS Excreted $_{Pig\ Class\ i}$ | Frac VS Excreted $_{Pig\ Class\ i}$ |
| Oats | | 88.1 | 2.6 | 85.5 | 64.1 | 68.1 | 30.7 | 27.2 |
| Oat groats | | 88.9 | 2 | 86.9 | 83.7 | 85.5 | 14.2 | 12.6 |
| Wheat, soft | | 86.1 | 1.5 | 84.6 | 87.6 | 89.2 | 10.5 | 9.2 |
| Maize | | 86.6 | 1.3 | 85.3 | 87.9 | 91.4 | 10.3 | 7.3 |
| Barley | | 86.6 | 2.2 | 84.4 | 80.6 | 82.8 | 16.4 | 14.5 |
| Rice, brown | | 88.3 | 4.1 | 84.2 | 97.5 | 97.8 | 2.1 | 1.9 |
| Rye | | 86.3 | 1.6 | 84.7 | 83.9 | 86.1 | 13.6 | 11.8 |
| Sorghum | | 87.5 | 1.9 | 85.6 | 87.3 | 88.9 | 10.9 | 9.5 |
| Triticale | | 86.9 | 1.8 | 85.1 | 86.3 | 87.8 | 11.7 | 10.4 |
| Wheat feed flour | | 86.2 | 2.8 | 83.4 | 90.1 | 91.3 | 8.3 | 7.3 |
| Wheat middlings | | 86.4 | 5.3 | 81.1 | 66.4 | 70.9 | 27.2 | 23.6 |
| Wheat bran | | 86.8 | 5.6 | 81.2 | 56.8 | 62.7 | 35.1 | 30.3 |
| Wheat gluten feed, starch 25% | | 90.3 | 4.8 | 85.5 | 72.5 | 76.1 | 23.5 | 20.4 |
| Corn gluten feed | | 89.3 | 6.5 | 82.8 | 65.7 | 76.5 | 28.4 | 19.5 |
| Corn gluten meal | | 89.9 | 1.6 | 88.3 | 94.1 | 96 | 5.2 | 3.5 |
| Corn distillers | | 90.6 | 5.9 | 84.7 | 65.9 | 76.4 | 28.9 | 20 |
| Maize feed flour | | 87 | 6 | 81 | 72.6 | 81.1 | 22.2 | 15.3 |
| Maize germ meal, solvent extracted | | 87.2 | 4.5 | 82.7 | 73.5 | 77 | 21.9 | 19 |
| Maize germ meal, expeller | | 90 | 5.8 | 84.2 | 75 | 78 | 21.1 | 18.5 |
| Brewers' dried grains | | 90.5 | 4.6 | 85.9 | 52.4 | 57.5 | 40.9 | 36.5 |
| Rice bran, extracted | | 89.8 | 12.7 | 77.1 | 58 | 64.6 | 32.4 | 27.3 |
| Rice bran, full fat | | 90.2 | 10.5 | 79.7 | 64.5 | 69.3 | 28.3 | 24.5 |
| Rapeseed, full fat | | 92.6 | 3.9 | 88.7 | 83 | 84.9 | 15.1 | 13.4 |
| Cottonseed, full fat | | 91.1 | 3.9 | 87.2 | 61.3 | 65.7 | 33.7 | 29.9 |
| Faba bean, white flowers | | 87.6 | 3.4 | 84.2 | 86 | 87.9 | 11.8 | 10.2 |
| Faba bean, coloured flowers | | 86.2 | 3.4 | 82.8 | 83 | 85.3 | 14.1 | 12.2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Linseed, full fat | 91 | 4.7 | 86.3 | 72.6 | 75.4 | 23.6 | 21.3 |
| Lupin, white | 87.8 | 3.9 | 83.9 | 81 | 85.8 | 15.9 | 11.9 |
| Pea | 87.2 | 2.9 | 84.3 | 88 | 91.2 | 10.1 | 7.4 |
| Soybean, full fat, toasted | 88.3 | 5.2 | 83.1 | 78 | 84.6 | 18.3 | 12.8 |
| Sunflower seed, full fat | 92.2 | 3.1 | 89.1 | 71 | 74.1 | 25.8 | 23.1 |
| Rapeseed meal | 91.3 | 7.9 | 83.4 | 67.5 | 72.5 | 27.1 | 22.9 |
| Linseed meal, solvent extracted | 89 | 6 | 83 | 75.8 | 79.1 | 20.1 | 17.4 |
| Linseed meal, expeller | 89.9 | 5.6 | 84.3 | 75.2 | 78.4 | 20.9 | 18.2 |
| Palm kernel meal, expeller | 91.6 | 4.2 | 87.4 | 42.3 | 49.9 | 50.4 | 43.8 |
| Sesame meal, expeller | 94.4 | 13 | 81.4 | 78.9 | 81.4 | 17.2 | 15.1 |
| Soybean meal, 46 | 87.4 | 6.5 | 80.9 | 85 | 90.4 | 12.1 | 7.8 |
| Soybean meal, 48 | 87.1 | 6.4 | 80.7 | 85.2 | 90.5 | 11.9 | 7.7 |
| Sunflower meal, undecorticated | 93.4 | 3.8 | 89.6 | 52.1 | 59.6 | 42.9 | 36.2 |
| Sunflower meal, partially decorticated | 94 | 3.3 | 90.7 | 58.9 | 65.3 | 37.3 | 31.5 |
| Maize starch | 86.7 | 1 | 85.7 | 98 | 98 | 1.7 | 1.7 |
| Cassava, starch 67% | 88.7 | 5.4 | 83.3 | 86.6 | 88.5 | 11.2 | 9.6 |
| Cassava, starch 72% | 88 | 4.1 | 83.9 | 92.9 | 94.1 | 6 | 4.9 |
| Sweet potato, dried | 87.4 | 3.3 | 84.1 | 90.4 | 91.8 | 8.1 | 6.9 |
| Potato protein concentrate | 90 | 2.2 | 87.8 | 94.5 | 95.2 | 4.8 | 4.2 |
| Soybean hulls | 88.4 | 4.8 | 83.6 | 51.4 | 70.3 | 40.6 | 24.8 |
| Molasses, beet | 73.7 | 8.3 | 65.4 | 85 | 87.6 | 9.8 | 8.1 |
| Molasses, sugarcane | 73.8 | 9.8 | 64 | 85 | 87.6 | 9.6 | 8 |
| Citrus pulp, dried | 90.3 | 6 | 84.3 | 74 | 82.4 | 21.9 | 14.9 |
| Beet pulp, dried | 90.1 | 6.7 | 83.4 | 72 | 81.3 | 23.4 | 15.6 |
| Beet pulp, dried, molasses added | 91.5 | 7.8 | 83.7 | 73 | 82 | 22.6 | 15.1 |
| Potato pulp, dried | 87.8 | 6.9 | 80.9 | 71.6 | 77.2 | 23 | 18.5 |
| Whey powder, acid | 95.6 | 21.1 | 74.5 | 95 | 95 | 3.7 | 3.7 |
| Whey powder, sweet | 96 | 8.2 | 87.8 | 95 | 95 | 4.4 | 4.4 |
| Milk powder, skimmed | 95 | 8 | 87 | 95 | 95 | 4.4 | 4.4 |
| Milk powder, whole | 94.9 | 6.3 | 88.6 | 93 | 93 | 6.2 | 6.2 |
| Fish meal, protein 62% | 91.8 | 17.6 | 74.2 | 85 | 85 | 11.1 | 11.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fish meal, protein 65% | 91.4 | 15.5 | 75.9 | 85 | 85 | 11.4 | 11.4 |
| Fish meal, protein 70% | 91.8 | 13.2 | 78.6 | 85 | 85 | 11.8 | 11.8 |
| Meat and bone meal, fat > 7,5 % | 93.8 | 34 | 59.8 | 70 | 70 | 17.9 | 17.9 |
| Oils and fats | 99.5 | 1 | 98.5 | 85 | 85 | 14.8 | 14.8 |
| L-Lysine HCL | 99 | 1 | 98 | 100 | 100 | 0 | 0 |
| L-Threonine | 99 | 1 | 98 | 100 | 100 | 0 | 0 |
| Tryptophan | 99 | 1 | 98 | 100 | 100 | 0 | 0 |
| DL-Methionine | 99 | 1 | 98 | 100 | 100 | 0 | 0 |
| Methionine Hydroxy Analog MHA | 99 | 1 | 98 | 100 | 100 | 0 | 0 |

[a] Dry matter and ash content from the data base of the CVB (Centraal Veevoederbureau, 1994).
[b] Organic matter was calculated as dry matter minus ash.
[c] Gross energy digestibility values for grower-finisher pigs and sows for each ingredient from the data base developed by INRA in France (2004).
[d] Volatile solids (VS) was calculated as organic matter * energy digestibility.

**TABLE A.2: Emissions Factor for Project Location and Climate, where information is available**

| Region | $EF_{Evap\ to\ Precip}$ ($kg\ N_2O\text{-}N/kgN$) |
|---|---|
| Prairie (Brown & Dark Brown) | 0.0016 |
| Prairie (Grey & Black) | 0.008 |
| Québec-Ontario | 0.012 |